

Remarks

Claims 6-9, 11, 14, 16, 18-50, 54, 56-58, and 63-71 are pending in the application. Of these claims, claims 9, 11, 16, 18-50, 54, and 56-58 are withdrawn from consideration.

35 U.S.C. § 112, ¶2 (Indefiniteness)

Claims 6-7, 14, 63-68 are rejected under 35 U.S.C. § 112, second paragraph, as being indefinite by the use of the term “metal-rich.” Applicants respectfully disagree with the Examiner’s holding, and believe the evidence and remarks submitted in the Response dated September 26, 2006, have explained why those skilled in the art would understand what is claimed when each of these claims is read in light of the specification, and have overcome the rejection.

However, to expedite the prosecution of the present application, Applicants have amended independent claims 6 and 7 as suggested by the Examiner. Claim 6 and 7 now further recite that “the total atomic amount of said aluminium and zirconium is higher than the total atomic amount of said oxygen, carbon, and nitrogen in said metal-rich zirconium-aluminium oxycarbonitride.” These amendments after final Office action were made complying with an requirement expressly set forth by the Examiner in the final Office action, and the Examiner suggests that such amendments would overcome this rejection. Therefore, Applicants respectfully request the Examiner to admit the amendments under 37 CFR § 1.116.

Claims 14 and 63-68 depend from either claim 6 or claim 7. It is therefore respectfully submitted that claims 6, 7, 14, and 63-68 are all definite under 35 U.S.C. § 112, second paragraph.

35 U.S.C. § 102(b) (Novelty)

Claims 6, 7, 14, and 63-68 are rejected under 35 U.S.C. 102(b) as being anticipated by Van Hartmetallw Immelbor (DD 288631) or Ver Edelstahlwerke AG (EP 149449). The rejections are respectfully traversed.

Claim 6 defines a decorative hard coating composition comprising a metal-rich zirconium-aluminium oxycarbonitride and requires that the metal-rich zirconium-aluminium oxycarbonitride has a lower atomic concentration of aluminium than of zirconium. Claim 7 further requires that the atomic concentration of aluminium is less than about one fifth that of zirconium. Both claims 6 and 7 have been amended to clarify that “the total atomic amount of said aluminium and zirconium is higher than the total atomic amount of said oxygen, carbon, and nitrogen in said metal-rich zirconium-aluminium oxycarbonitride.” Claim 14 and 63-68 depend from either claim 6 or claim 7. Neither DD 288631 nor EP 149449 teaches such hard coating compositions.

The Examiner contends that DD 288631 discloses oxycarbonitrides of Ti or Zr or Hf or mixtures thereof, which may further include an alumina phase having an Al content of 5-50 pts.wt., and therefore DD 288631 anticipates the invention as claimed in Claims 6, 7, 14 and 63-68. The Examiner also asserts that the newly presented hardness and CIELAB values in claims 63-68 are inherent to the oxycarbonitrides disclosed by the DD 288631 reference. The Examiner’s rejection of claims 6-7, 14 and 63-68 as being anticipated by DD 288631 is respectfully traversed for reasons detailed below.

The content of aluminium (5-50 pts.wt.) as disclosed in DD 288631 is the Al content in the alumina phase rather than in the oxycarbonitrides. DD 288631 does not disclose the relationship between the atomic contents of Al and Zr in the oxycarbonitrides. Therefore, DD 288631 does not teach a zirconium-aluminium oxycarbonitride that has a lower atomic concentration of aluminium than that of zirconium, and does not anticipate the coating compositions as claimed in claims 6, 7, 14 and 63-68.

More importantly, since aluminium was incorporated into the Zr oxycarbonitride in the form of alumina in DD 288631, the resultant film does not have a total amount of metal atoms higher than the total amount of the oxygen, carbon, and nitrogen atoms (hereinafter “OCN atoms”). Therefore, the films disclosed in DD 288631 fail to be metal-rich as required by claims 6 and 7 of the present application. When the total amount of metal atoms is not higher than the total amount of the OCN atoms, the resultant compounds will not be metallic and metallic-white. Typically, such resultant compounds from the prior art are snow-white, grey, yellow, brown, blue, purple, or black in color, as known in the art. Therefore, the coating compositions of the present application are different from those disclosed in DD 288631, and DD 288631 does not anticipate the coating compositions of claims 6, 7, 14 and 63-68.

Furthermore, as described in the present application, an increase in nitrogen content in the oxycarbonitrides would increase the hardness of a coating, but would deteriorate the whiteness (i.e. increase the CIELAB b value). Therefore, the hardness and CIELAB values presented in claims 63-68 are not inherent to the oxycarbonitrides disclosed in DD 288631, but are achieved by the specific oxycarbonitrides of those claims. In other words, the hardness and CIELAB values of claims 63-69 are characteristic parameters used to further define the specific oxycarbonitrides as claimed. Therefore, DD 288631 does not anticipate the coating compositions of claims 63-68 for this additional reason.

The Office action finds that EP 149449 discloses oxycarbonitrides of Ti or Zr including 0.1-2.5 atomic% Al. The Office action also finds that EP 149449 further discloses, in Examples 4 and 5, specific Zr-Al compounds.. The Office action then rejects claims 6, 7, 14 and 63-68 as being anticipated by EP 149449. This rejection is respectfully traversed for reasons as detailed below.

First, the Zr-Al compounds disclosed in Examples 4 and 5 of EP 149449 are oxycarbides rather than oxycarbonitrides because they do not contain nitrogen. Although EP 149449 mentions oxycarbonitrides of Zr, it does not disclose any specific Zr-Al oxycarbonitrides.

In addition, EP 149449 only mentions the Al content in the oxycarbonitrides but does not disclose the relationship between the contents of Al and Zr. Therefore, EP 149449 would not anticipate the coating compositions as claimed in the present application that require the oxycarbonitrides to have a lower atomic concentration of aluminium than that of zirconium. In fact, EP 149449 teaches the opposite. For example, both Examples 4 and 5 of EP 149449 used gas mixtures containing 10% AlCl₃ and 5% ZrCl₄ for the preparation of Zr-Al oxycarbide coatings. (The translation provided by the Examiner for EP 149449 appeared to be done by a machine, and is not accurate. The relevant parts of the translation for Examples 4 and 5 contain many errors. Applicants respectfully request the Examiner to refer to the original EP publication for accurate amounts of AlCl₃ and ZrCl₄ used in Examples 4 and 5.) It can be deduced from the information provided in Examples 4 and 5 that the atomic concentrations of aluminium in the resultant Zr-Al compounds of Examples 4 and 5 are higher than those of zirconium.

Furthermore, EP 149449 does not disclose zirconium-aluminium oxycarbonitrides containing a combined atomic amount of the aluminium and zirconium atoms higher than the combined atomic amount of the OCN atoms. In this regard, factual evidences can be found in Examples 4 to 5 of EP 149449 that relied on by the Examiner in the Office action. Although there is no clear description of compositional data of the Zr-Al compounds prepared in these examples, the gas compositions used in both cases give some clues of the metal:oxycarbide ratio in the resultant composition of the coatings formed by the chemical vapor deposition. In Example 4, the gas mixture used in the chemical vapor deposition had a molar ratio of CO₂:ZrCl₄:AlCl₃ of

5:5:10, in which the total amount (number) of carbon and oxygen atoms is equal to the total amount of metal atoms in the gas. In Example 5, the gas mixture had a molar ratio of CO₂:ZrCl₄:AlCl₃ of 12:5:10, in which the total amount of carbon and oxygen atoms is much greater than the total amount of the metal atoms in the gas. Similar gas compositions were used in EP 149449 to make Zr-Al oxide/oxycarbide coatings with optimized hardness and cutting performance, as shown throughout the disclosure of EP 149449.

As described in the specification, the metal-rich zirconium-aluminium oxycarbonitrides of the present application that contain a combined amount of the aluminium and zirconium atoms higher than the combined amount of the OCN atoms represent a new class of oxycarbonitride materials. Therefore, the hard coating compositions of claims 6, 7, 14 and 63-68 of the present application are novel and cannot be anticipated by EP 149449.

35 U.S.C. §103(a) (Obviousness)

Claims 6-8, 14, and 63-71 are rejected under 35 U.S.C. 103(a) as being unpatentable over Gates, Jr. (4,714,660) for obviousness. For reasons detailed below, Applicants respectfully traverse the rejection.

First, the Gates reference does not teach or suggest metal-rich oxycarbonitrides containing a combined amount of aluminium and zirconium atoms higher than the combined amount of OCN atoms.

The Gates reference discloses a formation of coatings comprising a mixture of Ti_wAl_xO_yC_zN_n solid solution (with w+x = 1 and y+z+n=1, as shown in, for example, Example 2) with TiN, TiC, and/or Al₂O₃. Therefore, the total number of metal atoms in the resultant coatings of the Gates reference cannot be higher than the total number of the OCN atoms. This

can be further clarified by the following summary of the examples in the Gates reference which were used by Gates to illustrate the compositional nature of his coatings.

In Example 1, Gates used EDAX and X-ray diffraction to show that the coating was a single phase TiAlOC solid solution. The total number of metal atoms was thus not higher than the total number of O and C atoms.

In Example 2, the X-ray diffraction pattern of the coating showed it to be composed of a TiAlOC solid solution and alpha Al₂O₃. Gates showed that the composition of the solid solution was “Ti_{0.85}Al_{0.15}O_{0.5}C_{0.5}”. Therefore, the total number of metal atoms was smaller than the total number of O and C atoms for the coatings which had Al₂O₃ in addition to the Ti_{0.85}Al_{0.15}O_{0.5}C_{0.5} solid solution.

Example 3 gave coatings composed of about 68 weight% of Al₂O₃ and 32 weight% of TiC. Therefore, the total number of metal atoms was less than the total number of O and C atoms.

Example 4 showed that the composition of the “gas phase precipitate” remained nearly constant at a weight ratio of about 70% Al₂O₃ and 30% TiC along with a small amount of TiAlOC solid solution. Therefore, the total number of metal atoms should be less than the total number of O and C atoms.

Example 5 showed the wear resistance and cutting performance of the coatings. All coatings tested were similar to those of Examples 1-4, and no metal-rich coatings were tested.

Example 6 showed a new type of coatings with the addition of nitrogen in the chemical vapor deposition process. The coatings comprised of a TiAlOCN solid solution and rods of Al₂O₃. The TiAlOCN solid solution was produced by modifying the TiAlOC coatings using an input gas composition comprising 76.6% to 76.8% hydrogen-containing gas, 18.4% N₂, 3.9%

CO, 0.8% AlCl₃ and varying amounts of LiCl₄. Therefore, the total number of metal atoms would be no more than the total number of the OCN atoms. In fact, the composition of the input gas composition (18.4% N₂, 3.9% CO, 0.8% AlCl₃, <0.45% TiCl₄) indicates that the total number of metal atoms in the resultant coating would be less than the total number of the OCN atoms. Further, Example 6 suggests that the coating is “probably a nitrogen-rich TiAlOCN phase that is produced because the nitrogen gas is one of the first gases introduced into the reactor at the start of the deposition.” Col. 11, lines 32-35.

Example 7 showed yet another type of coatings with the replacement of Ti with Zr. The coatings comprised a ZrAlOCN solid solution and Al₂O₃. The ZrAlOCN solid solution was accomplished by chemical vapor deposition using an input gas composition comprising 75.7% hydrogen-containing gas, 18.9% N₂, 4.0% CO, 0.8% AlCl₃ and 0.6% ZrCl₄. Therefore, the total number of metal atoms is smaller than the total number of the OCN atoms. In fact, the composition of the input gas composition (18.9% N₂, 4.0% CO, 0.8% AlCl₃, 0.6% ZrCl₄) indicates that the total number of metal atoms in the resultant coating would be smaller than the total number of the OCN atoms. Because nitrogen gas is one of the first gases introduced into the reactor at the start of the deposition, it could reasonably be concluded that the ZrAlOCN produced by Example 7 probably is nitrogen-rich, just as the TiAlOCN in Example 6.

In addition to the direct factual evidences as discussed above showing that the Gates reference does not disclose or suggest metal-rich oxycarbonitride coatings with a total number of metal atoms higher than the total number of OCN atoms, it is known in the field of the present invention and in the literature that the chemical vapor deposition conditions described in the Gates reference are typical of those used for the synthesis of stoichiometric (or nitrogen-rich) oxide, nitride, carbide and oxycarbonitride compounds of Ti and Zr, with or without the

additional of Al. Such stoichiometric or nitrogen-rich compounds all have a composition with a total number of metal atoms smaller than or equal to the total number of the OCN atoms. These compounds are known to have very high mechanical hardness. Therefore, the Gates reference has adopted them in its invention for ultra hard coatings. In comparison, the present application disclose and claim metal-rich deposition coatings, which preferably having a platinum-like metallic-white visual appearance that are achieved by Zr-Al oxycarbonitrides with a total number of the Zr and Al atoms greater than the total number of the OCN atoms.

Further, the Gates reference only mentions that a variation of the composition of an oxycarbonitride may impact the color thereof, but does not teach how to adjust the composition of the oxycarbonitride to increase the whiteness thereof while keeping or improving its hardness. As shown by Table 1 of the Gates reference, none of the coatings studied there has a metallic-white color. Since a Zr-Al oxycarbonitride is made up of at least five elements Zr, Al, O, C and N, it would be difficult and non-obvious for one of ordinary skill in the art to adjust the ratio between these elements to achieve the desired technical effects of the present invention, particularly the technical effects of a platinum-like metallic-white appearance of claims 63-71 of the present invention.

Moreover, the Gates reference actually teaches a nitrogen-rich TiAlOCN or ZrAlOCN coating, see col. 11, lines 32-35, which is teaching away from a metal-rich oxycarbonitride of the present technology. As described in the present application, an increase in nitrogen content in the oxycarbonitrides would increase the hardness of a coating, but would deteriorate the whiteness (i.e. increase the CIELAB b value). Therefore, the hardness and CIELAB values presented in claims 63-71 are not obvious to the oxycarbonitrides disclosed in the Gates reference.

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Therefore, no prima facie case of obviousness of claims 6-8, 14, and 63-71 can be established over the Gates reference.

For reasons stated above, claims 6-8, 14, and 63-71 all define patentable subject matter, and should be allowed.

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Conclusion

In view of the above remarks, Applicants respectfully request reconsideration of the present application, and allowance of pending claims (6-8, 14 and 63-71).

The Commissioner is hereby authorized to charge any additional fees or credit any overpayment, to Deposit Account No. 13-0017.

Respectfully submitted,



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